the ENERGY lab
PROJECT FACTS

Project No: NT0000749
Performer: Southern Company Services, Inc.

Advanced Energy Systems - Gasification Systems

Modification of the Developmental Pressure Decoupled Advanced Coal (PDAC) Feeder

Project Description

The National Carbon Capture Center has been developing an innovative feed system, the Pressure Decoupled Advanced Coal (PDAC) feeder, a non-mechanical feed control device with no moving parts. In order to increase fuel flexibility for advanced coal-fired power systems, the PDAC is designed to handle a wide range of solid fuels. The driving force for solids flow is a pressure differential, and the solids flow is metered by the conveying gas. Current plans to optimize the performance of the PDAC include running the equipment at higher flow rates than have been achieved during normal gasifier testing. Testing results are expected to expand the operating window of the instruments and provide lower-cost operational improvements for a broad range of commercial gasifiers and the feeding of a variety of fuels including inexpensive and widely-available low-rank coals.

Program Background and Project Benefits

Gasification is used to convert a solid feedstock, such as coal, petcoke, or biomass, into a gaseous form, referred to as synthesis gas or syngas, which is primarily hydrogen and carbon monoxide. With gasification-based technologies, pollutants can be captured and disposed of or converted to useful products. Gasification can generate clean power by adding steam to the syngas in a water-gas-shift reactor to convert the carbon monoxide to carbon dioxide (CO_2) and to produce additional hydrogen. The hydrogen and CO_2 are separated—the hydrogen is used to make power and the CO_2 is sent to storage, converted to useful products or used for EOR. In addition to efficiently producing electric power, a wide range of transportation fuels and chemicals can be produced from the cleaned syngas, thereby providing the flexibility needed to capitalize on the changing economic market. As a result, gasification provides a flexible technology option for using domestically available resources while meeting future environmental emission standards. Polygeneration plants that produce multiple products are uniquely possible with gasification technologies. The Gasification Systems program is

developing technologies in three key areas to reduce the cost and increase the efficiency of producing syngas: (1) Feed Systems, (2) Gasifier Optimization and Plant Supporting Systems, and (3) Syngas Processing Systems.

Feed systems research is underway to reduce the cost and increase the efficiency, through design and advanced plant integration, of fuel and oxygen feed to commercial gasifiers. High-pressure solid feed systems will expand the use of our nation's Western low-cost, low-rank coals for high-pressure gasifiers (currently limited to more expensive fuel), enable co-feeding of coal with other advantageous fuels (such as biomass), and encourage higher pressure (and therefore more efficient) operation of dry feed gasifiers. ITM technology will lower the cost of oxygen production through reduced capital costs, and result in more efficient IGCC power plants through turbine integration, as compared to today's commercially available, energy intensive technology for oxygen production—cryogenic air separation.

The National Carbon Capture Center (NCCC) is developing the Pressure Decoupled Advanced Coal (PDAC) feeder to operate with a wide variety of coals and biomass feedstocks to increase the fuel flexibility of integrated gasification combined cycle (IGCC) systems. The PDAC feeder is a non-mechanical feed control device with no moving parts which combines successful novel concepts (developed for continuous ash depressurization systems) with traditional designs for flow rate control. The driving force for solids flow is a pressure differential, and the solids flow is metered by the conveying gas. Successful development of high-pressure solid feed systems enables utilization of the Nation's large reserves of low-cost, low-rank coals in dry feeding of high-pressure gasifiers, allows for the co-feeding of coal with other advantageous fuels (such as biomass), and provides for higher pressure (and therefore more efficient) operation of dry-feed gasifiers.

Project Scope and Technology Readiness Level

This project will advance PDAC feeder operation through mechanical and control modifications. Feeder testing utilizing an offline feed system will be conducted at higher pressures and coal feed rates. Coal feeder level probes and new coal flow measurement devices will be evaluated. Fuel flexibility of the feeder will be enhanced by testing with other potential gasifier feed-stocks. Other dry solids feed systems and components will be investigated and tested as available.

The Technology Readiness Level (TRL) assessment identifies the current state of readiness of the key technologies being developed under the DOE's Clean Coal Research Program. In FY 12, this project was assessed a TRL of 5.

The TRL assessment process and its results including definition and description of the levels may be found in the "2012 Technology Readiness Assessment-Analysis of Active Research Portfolio".

Accomplishments

- The PDAC feeder has operated for approximately 6,900 hours at coal feed rates between 750 and 5,700 pounds per hour (lb/hr) during gasification operation. Coal feed rates as high as 8,500 lb/hr have been achieved while utilizing the high pressure offline test system. Gasifier feed stocks tested to date include subbituminous and lignite coals and coke breeze.
- Several non-intrusive coal flow measurement devices have been tested to provide instantaneous indication of coal feed rate changes. Most recently, performance of a dense flow coal meter was evaluated over the course of several gasification runs. The device provides measurement of coal density and velocity in the discharge line to the gasifier and uses these measurements to calculate a mass flow rate.
- Dynatrol vibration level probes installed in the PDAC feeder to dispense and lock vessels have operated for more than 6,000 hours. The probes have consistently indicated solids levels inside the vessels for both lignite and subbituminous coals. The high reliability of the probes allowed for control logic modifications to optimize the lock vessel filling cycle and provide a wider range of operational capability.
- The Drexelbrook point sensitive level probe, installed in the top of the PDAC feeder dispense vessel, has continuously provided steady solids level control, mitigating the impact of solids level variation on coal feed rate. A total of 5,000 hours of reliable operation has been achieved to date.
- Modifications were made to better distribute nitrogen gas to the bottom of the PDAC feeder, resulting in improved coal flow rate control and overall nitrogen flow control.
- Improvements have been made to the PDAC feeder control logic to provide improved control of dispense vessel pressure, resulting in a more consistent coal feed rate to the gasifier. Additional control improvements include several feedback controllers to modulate conveying gas flow to the feeder to maintain steady coal feed to the gasifier. These include feedback control on instantaneous coal feed rate utilizing a differential pressure transmitter (which can be modified in the future to use other coal flow measurement devices) and feedback control on sudden changes in gasifier pressure.
- Preliminary testing has also been conducted using temperature indications in the gasifier mixing zone to adjust conveying gas to the feeder.

Contacts, Duration, and Cost

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Duration
Start Date: 10/01/2008
End Date: 09/30/2014

Cost
Total Project Value: $251,454,148
DOE Share: $201,163,318
Non-DOE Share: $50,290,830

Performer website: National Carbon Capture Center